
# USGS Update on Landsat Next

## National Geospatial Advisory Committee

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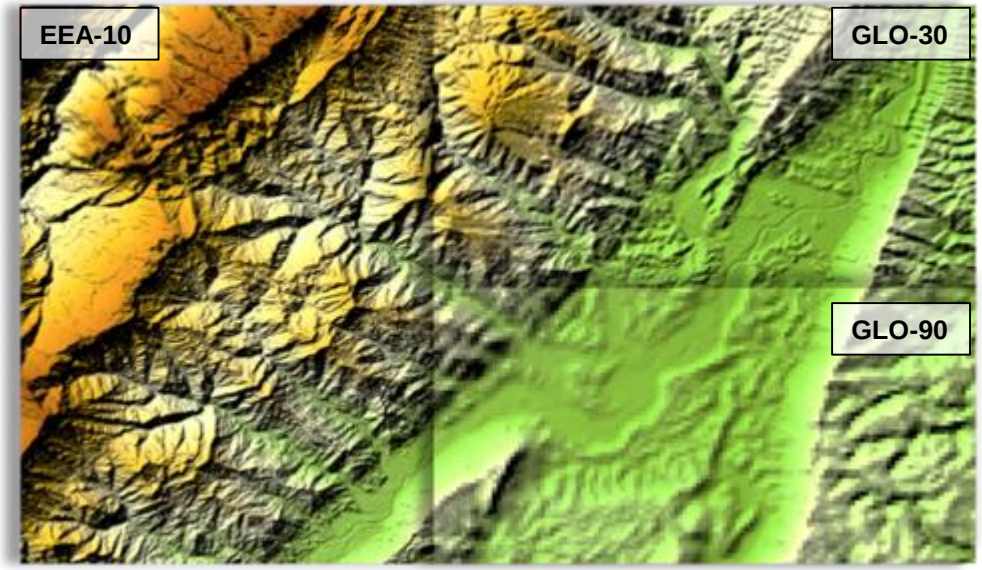
# Copernicus DEM

- **The EC and ESA announced at the beginning of November that their global 30-meter Digital Elevation Model (DEM) GLO-30 would now be open to the public**
  - Decision followed ongoing discussions with USGS and EROS – highlighting the value of multilateral partnerships
- **This global dataset is more consistent and of higher quality than other freely available global DEMs**
  - Expected to provide higher confidence in products
  - GLO-30 DEM can also help improve current alignment of Sentinel-2 and Landsat imagery, and improve interoperability



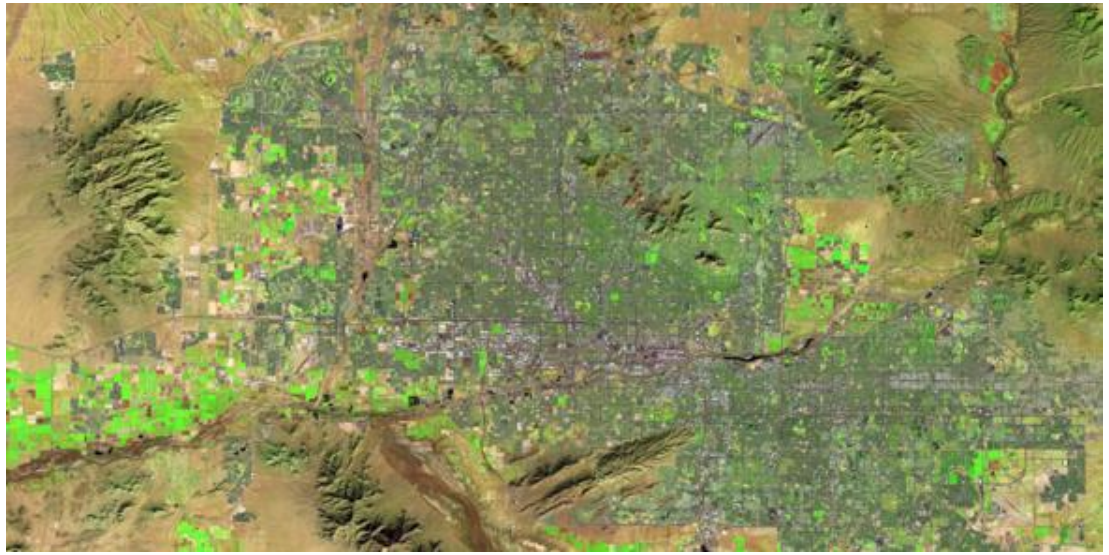

Copernicus DEM Instances EEA-10 (left), GLO-30 (upper right) and GLO-90 (lower right) (Courtesy Copernicus)

# Landsat Collection 2

## ➢ Landsat Collection 2 publicly released last week

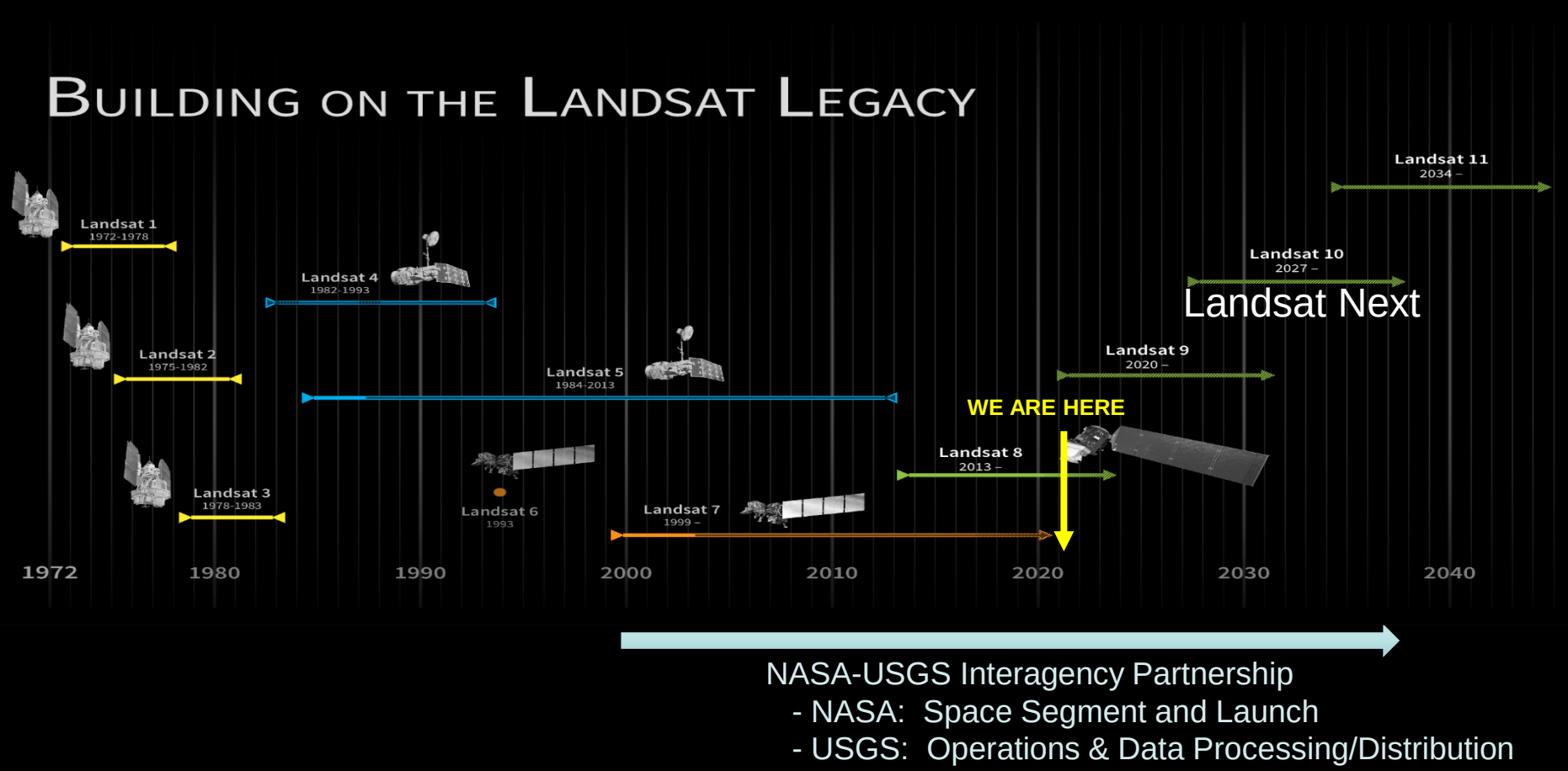
- Cloud-hosted, using Amazon Web Services
- Can be accessed and downloaded similarly to Collection 1
- Still free to the public
- Collection 1 to be maintained in parallel for 1 year

- Improved Geometric Accuracy using Landsat 8 and Europe's Sentinel-2 Global Reference Image (GRI)
- Improved Digital Elevation Model (DEM)
- Improved Radiometric Calibration for Landsat 5 and Landsat 8
- Global Level-2 Surface Reflectance/Temperature Data and Atmospheric Auxiliary Products
- Consistent Quality Assessment Bands
- Updated and Consistent Metadata Files
- Cloud Optimized File Format



The official USGS Landsat Missions Web Site Collection 2 documentation is located at:

https://usgs.gov/land-resources/nli/landsat/landsat-collection-2




- **<u>Sustainable Land Imaging (SLI)</u> is a partnership between DOI/USGS and NASA to maintain a sustainable program for spaceborne land imaging**
  - ❑ Landsat-9 development is on track to meet a FY 2021 launch date
  - ❑ USGS documented user requirements across Federal agencies; NASA conducted technology investigations to reduce cost and risk in future missions
  - ❑ Joint SLI Architecture Study Team (AST) completed its final report; AST delivered a set of viable architecture concepts for the next mission providing a basis for formulating future acquisition strategies
    - » NASA and USGS Leadership working to develop details and options as part of their FY 2022 budget requests

# Landsat Next Recent Developments

- **NASA and USGS addressing Pre-Phase A studies for Landsat Next mission**
  - Pre-Phase A activities anticipated to conclude in 2021

- **First steps are to refine spectral bands, their spatial resolution, and radiometric quality**

- **Priorities for band definition include:**
  - Continuity with heritage Landsat bands
  - Synergy with European Copernicus Sentinel-2 / Land Surface Temperature Missions
  - Support for new, high-priority emerging applications
  - Improved atmospheric correction and surface temperature retrieval

- **Landsat Next Request for Information (RFI)**
  - RFI posted 13 October 2020: Landsat Next RFI
  - RFI sought feedback on mission science requirements, instrumentation solutions, architecture approaches

  Side Note: Congressional Research Service released a report entitled “Landsat 9 and the Future of Sustainable Land Imaging Program” on October 5, 2020

# RFI Proposed Landsat Next capabilities

| | Landsat 8/9 | Landsat Next Concept |
|---|---|---|
| Spectral bands | 9 VSWIR, 2 TIR | 20 VSWIR, 5 TIR |
| Spatial resolution | 15m panchromatic, 30m VSWIR, 120m TIR | 10/20/30/60m VSWIR, 60m TIR |
| Temporal revisit | 16 days | <= 16 days |
| SNR (VSWIR) | OLI heritage | OLI heritage (when aggregated to 30m) |
| NEdT (TIR, @300K) | <0.4K required | <0.2K required |
| Radiometric Accuracy (VSWIR) | <5% at-sensor radiance error, <3% reflectance | <5% at-sensor radiance error, <3% reflectance |
| Radiometric Accuracy (TIR) | <2% radiance error @ 300K (1 sigma) | <1% radiance error @ 300K (1 sigma) |

# RFI Proposed Landsat Next architecture options

| | Constellation Observatory | Single-Platform Observatory |
|---|---|---|
| Global land revisit | <=16 days | <=16 days |
| Orbit | Sun-synch, altitude TBD | Sun-synch, altitude TBD |
| Instruments per platform | 1 (VSWIR+TIR) or 2 (VSWIR, TIR) | 1 (VSWIR+TIR) or 2 (VSWIR, TIR) |
| Platforms | Notionally 3 to 5 | 1 |
| Swath-width per platform | 40-80km | >=185km |
| Risk Approach | Constellation Class B, via redundant Class C or lower platforms | Class B |

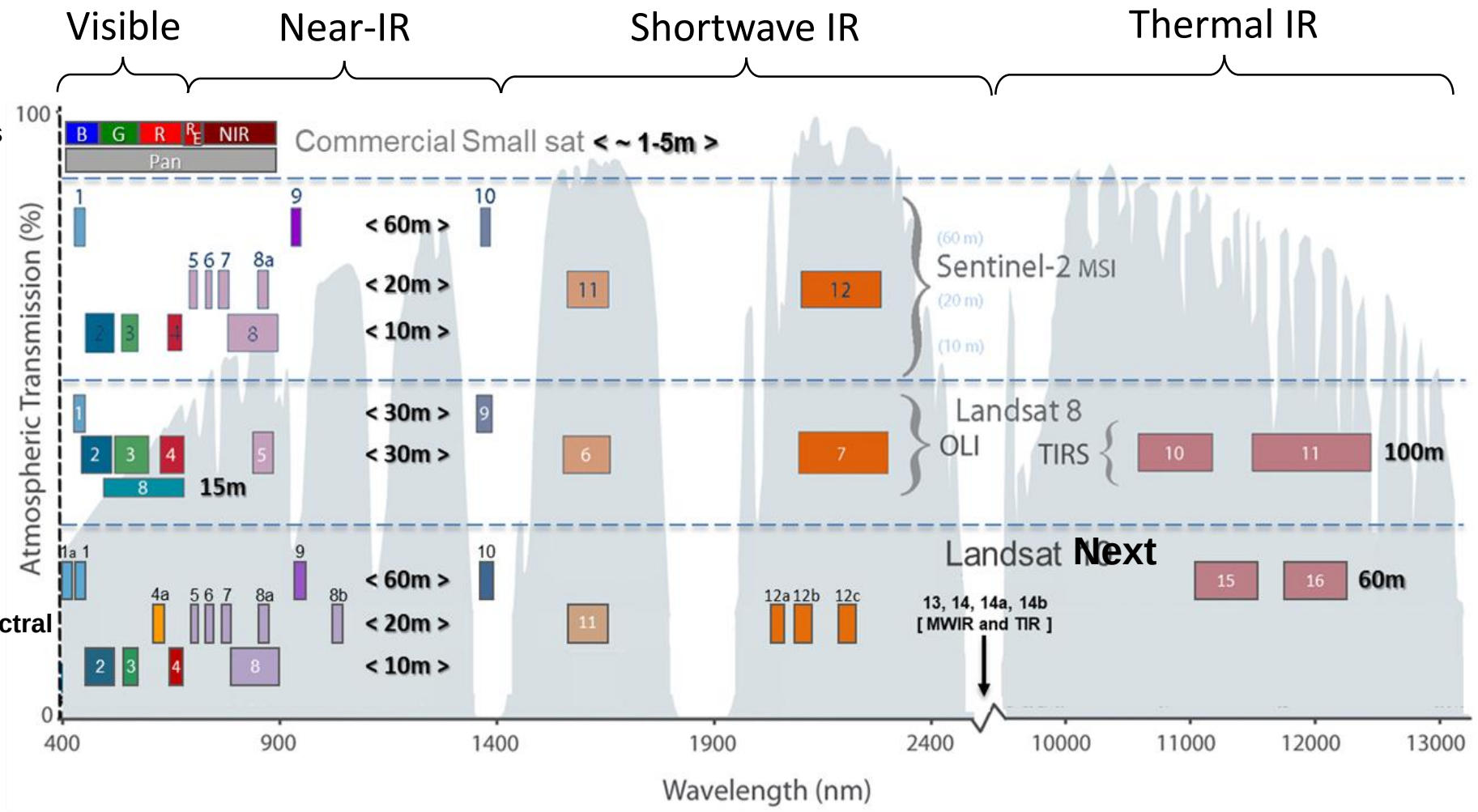
# RFI Draft SLI "Superspectral" Requirements

- **RFI draft "superspectral" spectral bands**
  - Included Sentinel-2 bands
  - Added narrow bands for aquatic and cryosphere
  - Shifted SWIR bands for crop residue
  - Shifted/narrowed TIR bands for temperature/emissivity
  - Coastal aerosol at 30m for aquatic and mineral applications
- **Radiometric quality intended to match Landsat 8 OLI when aggregated to 30m**

| | Band name | Ground Sample Distance (m) | Center wavelength (nm) | Band width (nm) | Rationale |
|---|---|---|---|---|---|
| **1** | Violet | 60 | 410 | 20 | Improved aerosol retrieval; CDOM from inland/coastal water |
| **2** | Coastal Aerosol | 30 | 443 | 20 | Landsat |
| **3** | Blue | 10 | 490 | 65 | Landsat |
| **4** | Green | 10 | 560 | 35 | Landsat |
| **5** | Orange | 20 | 620 | 20 | Phycocyanin detection for Harmful Algal Blooms |
| **6** | Red 1 | 20 | 650 | 20 | Phycocyanin, chlorophyll |
| **7** | Red 2 | 10 | 665 | 30 | Landsat |
| **8** | Red Edge 1 | 20 | 705 | 15 | LAI, Chlorophyll, plant stress (S2) |
| **9** | Red Edge 2 | 20 | 740 | 15 | LAI, Chlorophyll, plant stress (S2) |
| **10** | NIR Broad | 10 | 842 | 115 | 10m NDVI (S2) |
| **11** | NIR1 | 20 | 865 | 20 | Continuity (note – S2 narrower than L8) |
| **12** | Water vapor | 60 | 945 | 20 | Improved atmospheric correction for LST, SR (S2) |
| **13** | Liquid Water | 20 | 985 | 20 | Liquid water, surface water state |
| **14** | Snow/Ice 1 | 20 | 1035 | 20 | Snow grain size for water resources |
| **15** | Snow/Ice 2 | 20 | 1090 | 20 | Ice absorption, snow grain size |
| **16** | Cirrus | 60 | 1375 | 30 | Landsat |
| **17** | SWIR 1 | 20 | 1610 | 90 | Landsat |
| **18** | SWIR 2a | 20 | 2100 | 30 | Subdivided for cellulose/crop residue measurement (Landsat) |
| **19** | SWIR 2b | 20 | 2210 | 40 | Subdivided for cellulose/crop residue measurement (Landsat/ASTER) |
| **20** | SWIR 2c | 20 | 2260 | 40 | Subdivided for cellulose/crop residue measurement (Landsat/ASTER) |
| **21** | TIR 1 | 60 | 8300 | 250 | Mineral and surface composition mapping (ASTER) |
| **22** | TIR 2 | 60 | 8600 | 350 | Emissivity separation, volcanos (SO2) (MODIS/ASTER) |
| **23** | TIR 3 | 60 | 9100 | 350 | Mineral and surface composition mapping (ASTER) |
| **24** | TIR 4 | 60 | 11300 | 550 | Surface temperature (Landsat), carbonates |
| **25** | TIR 5 | 60 | 12000 | 550 | Surface temperature, snow grain size (Landsat) |

# Spectral Band Comparisons

*Among Commercial Smallsats, European Sentinel-2, Landsat 8/9 & Proposed Superspectral Landsat Next*




**New Landsat Next spectral bands enable/improve the following applications:**

- Improved aerosol retrieval; Colored dissolved organic matter from inland/coastal water
- Phycocyanin detection for HABs
- Leaf Area Index, Chlorophyll, plant stress
- Water quality
- Improved atmospheric correction for temperature, surface reflectance
- Snow grain size for water resources
- Cellulose/crop residue
- Active fire, volcanos, fire radiative power
- Mineral and surface composition mapping
- Emissivity separation, volcanic SO2

# Ideas for 2021 LAG Tasks

- **What are the programmatic, technical and policy considerations that NLI should be addressing as it considers strategies for improved cross-calibration and interoperability with national, international and commercial datasets to augment Landsat observations?**
- **In the "Landsat in the Cloud Era," what innovations should NLI consider a priority in providing data and information products? Improving ARD? Improving exploitation infrastructure? Ohers?**
- **What are some near-term technical challenges (like applying data cubes in forecasting) and how can NLI best position itself to meet them?**
- **An updated assessment on the economic value of Landsat data—with specific case studies--would be timely given the development of Landsat Next.**
- **As a global survey tool, how could Landsat data be used to inform the scientific community in regards to future pandemic surveillance, monitoring and response?**
- **How can the integrated collection of satellite, in situ and airborne data impact climate change research?**

# National Land Imaging (NLI) Program Future Directions

*Leveraging the diversity of Earth Observations to meet the Diverse Needs of Science & Operational Users*

## NLI Program Goals

- **Improve Operational Capabilities**
- **Enhance Research, Development and Innovation**
- **Expand Product and Service Usability**
- **Ensure Community Engagement**